THE EVALUATION OF PERIODS WITH PLUVIOMETRIC SURPLUS AND DEFICIT IN CIBIN HYDROGRAPHIC BASIN – A WAY FOR SUSTAINABLE DEVELOPMENT

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Abstract
Cibin Basin has, in the 2237 km^2 on which it stretches, a level difference of over 1700 m between its spring (the glacial circle in the Cindrel Mountains where Iezerul Mare and Iezerul Mic are situated) and its mouth (Sadu-Hârtibaciu-Cibin-Olt confluence area). The altitude plays a determinant role in the precipitations regime. Besides, the configuration of the relief also leaves its mark upon the moving air masses, determining the formation of types of precipitations. The analysis of the long data ranges offers an ensemble image regarding the succession of periods with pluviometric surplus and deficit for Cibin hydrographic basin. This approach allows the identification of a possible cyclicity of the episodes with floodings and droughts. The quantity of precipitations fallen in the area of Cibin hydrographic basin has been grouped according to deviation classes (one normal class and five classes for each of the quantities that are higher and lower than the normal) and to pluviometric domains (where there have been gathered the values of all the classes with positive and negative deviations, comparing them to the normal domain). The analysis of the annual regime of precipitations in Cibin hydrographic basin for the interval 1961-2009 and that of the frequency with which precipitations have been registered on different risk classes denote that in Sibiu only a low risk of surplus and deficit is manifested, in Agnita the extreme values with medium and major risk are of deficitary nature, and in Păltiniş the extremes of medium and major risk are characteristic to the surplus quantities.

Key words: precipitations, percentual deviation of rainfall quantity, pluviometrical risk, sustainable development

INTRODUCTION

Floods are natural phenomena that are necessary for the survival and health of the eco-system. Floodplains have historically attracted socio-economic development and continue to support high densities of human population. This is particularly important where land resources suitable for human development are scarce. Flood waters represent a vital water resource. Floods can, however, also lead to wide-spread damage, health problems and the loss of human life. This is especially the case where development activities in the river channel and the adjacent floodplain have been pursued without taking into account the associated risks. An integrated approach to flood management, recognizing on the one hand the opportunities provided by floodplains for development and on the other hand the importance of managing the associated risks, is essential for sustainable development of river basins. The basic aim should be to minimize loss of human life and the economic and environmental damage caused by floods while maximizing floodplains' efficient use. Floods do not respect borders, neither national nor regional or institutional. This means flood risk management must be trans-boundary. The great advantages of trans-boundary cooperation are that it broadens the knowledge/information base, enlarges the set of avail-able strategies and enables better and more cost-effective solutions. In addition, widening the geographical area considered by basin planning enables measures to be located where they create the optimum effect. Finally, disaster management is highly dependent on early information and requires forecasts and data from the river basin as a whole. Expected climate change impacts represent an additional challenge. Different perceptions of the problems are an obstacle, and should be overcome through communication, joint monitoring and exchange of data. Common understandings of the problems involved and common interests are necessary preconditions for finding effective solutions.

Cibin Basin has, in the 2237 km^2 on which it stretches, a level difference of over 1700 m between its spring (the glacial circle in the Cindrel Mountains where Iezerul Mare and Iezerul Mic are situated) and its mouth (Sadu-Hârtibaciu-Cibin-Olt confluence area).The altitude plays a determinant role in the precipitations regime. Besides, the configuration of the relief also leaves its mark upon the moving air masses, determining the formation of types of precipitations.

Cibin hydrographic basin stretches at the contact of the Meridional Carpathians with the Transilvanian Depresssion, in its South-Western sector. Although Cibin hydrographic basin is of medium stretch, its complexity demonstrates the necessity of the detailed analysis of such hydrographic basins, especially when these are crossing different relief forms.

The morphology of the system is characterized by three main forms of relief: the Southern mountain border that is made of the Northern flank of the Cindrel Mountains, the central depression area overlapping the Sibiu Depression and the Hârtibaciu hills area.

The geographical position of Cibin hydrographic basin leaves its mark on the ensemble climatical characteristics, the area being situated both in the mountain climatical region (the high region of the Cindrel Mountains), and in the plateau climatical region (Sibiu Depression and Hârtibaciu plateau). Among the geographical factors, the relief has the most important role. As a climatogene factor, the relief is imposing through altitude, versants exposure, slope and the configuration of its forms.

The altitude determines the modification on the vertical of all the climatical elements.

The atmospherical precipitations increase as the altitude increases, up to a certain height, called pluviometrical optimum, beyond which they begin to decrease. The differences that occur between the quantities of precipitations registered in the Sibiu Depression and the Hârtibaciu Plateau are due to the frontolysis, as a result of the foehn effect, the frontogenesis and the intensification of the continentalism effect.

The versants exposure imprints differentiations between the Southern versants, which receive lower quantities of precipitations, as compared to the Northern ones, where the precipitations quantities are greater. The versants that are sheltered from the general atmospherical circulation (the Eastern versants) receive lower quantities of precipitations, as compared to the Western ones.

The inclination of versants has an important role in the differentiate warming of the surfaces with different slopes, thus the role in the repartition of the precipitations quantity.

The configuration of the relief determines the modification of the climatical elements. In the concave forms (depression, valley lanes) there are frequent temperature inversions, the frost persists, the wind is lower, and the precipitations are reduced. In the convex forms (crests, peaks) the wind speed gets higher, as well as the orographic convection having significant implications in increasing the quantity of precipitations. (Busuioc A., 1992)

MATERIAL AND METHODS

The interest for the study of climate in the area of Cibin hydrographic basin has been materialized in numerous works, beginning with the 19th century. Under the conditions in which the pluviometric surplus or deficit become risk factors, their study and the study of the effects they have on the natural and socio-economic environment is fully entitled. The

climatologists have the role of analyzing these risk phenomena, taking part in the identification, limitation and prevention of the negative effects of floodings and droughts. Through the modernization of the research methods and the introduction of the computerized methods of data processing, studies regarding the atmospheric precipitations are being realized with the help of general or specific statistical methods.
The quantity of precipitations fallen in the area of Cibin hydrographic basin has been grouped according to deviation classes (one normal class and five classes for each of the quantities that are higher and lower than the normal) and to pluviometric domains (where there have been gathered the values of all the classes with positive and negative deviations, comparing them to the normal domain). Then there have been established groups of pluviometric risk through surplus and deficit, to these being added the group with no pluviometric risk.

RESULTS AND DISCUSSIONS

In the temporal and spatial analysis of the periods with pluviometric surplus and deficit there are difficulties associated with the establishment of the control variables and threshold values that are being used, difficulties induced by the complexity of the phenomena of interest. Precipitations influence the geographic environment both in space and in time. (Bălteanu, D., Alexe, R., 2000)
The spatial distribution denotes the interdependence and interconditioning of precipitations with each of the elements of the geographic environment and with all of them together, in a living system that is continuously changing.
The map of annual isohyets shows the entirety of factors that influence during a year the territorial distribution of the quantities of precipitations, from the atmospheric circulation imposed by the distribution of the baric centres, to the effect of local conditions, primarily that of the relief. Overlapping over three distinct relief units (mountain, depression, and plateau), Cibin hydrographic basin has an altitude difference of over 1700 m between its spring and its mouth. This aspect is obvious in the repartition of precipitations.
The multiannual precipitations regime is characterized by great unperiodical variations that highlight the succession of pluviometric periods with surplus and deficit, which impose practical measures of prevention and limitation of the negative influences caused by these phenomena.
Because of the continuous fluctuations of the general circulation of the atmosphere, that are determined by the frequency of the movement and the stagnation and development duration of the baric systems, the atmospherical fronts, and the nature of the air masses, the quantities of precipitations significantly vary from one year to the other.
The altitude difference between the points of precipitations measurement explains only partially the difference between the average multiannual quantities of precipitations, an important role also being played by the configuration of the active surface, and the general circulation of air masses.
The multiannual precipitations averages decrease from South to North, as the altitude decreases, and from West to East, in the sense of the increase of the degree of continentalism. As compared to these average multiannual values, there are also being registered a series of positive and negative deviations that characterize the precipitations surplus or deficit. Thus, the highest values have frequently exceeded 800-900 mm/year in the depression and plateau area and 1900 mm/year in the mountain region. The lowest values have been far under 400 mm/year, and there have even been situations with values of 160-250 mm/year.
The analysis of the annual regime of precipitations in Cibin hydrographic basin for the interval 1961-2009 and that of the frequency with which there have been registered

precipitations on different classes of risk denotes that in Sibiu there is only a low surplus and deficit risk, in Agnita the extreme values with average and major risk are of deficitary nature, while in Păltiniş the extremes of average and major risk are characteristic to the quantities with surplus.
The analysis of the frequency with which precipitations have been registered on different risk classes denote that in Sibiu only a low risk of surplus and deficit is manifested, in Agnita the extreme values with medium and major risk are of deficitary nature, and in Păltiniş the extremes of medium and major risk are characteristic to the surplus quantities.
The frequency of the years with pluviometric risk through surplus is low in the depression and plateau area, but it is worth mentioning that in the mountains the risk through surplus reaches 20%, and the one through deficit 15,6%. The risk through surplus signalled in the mountain region also spreads in the rest of the area, especially in Sibiu Depression, generating hydrologic risk (Fig. 1).

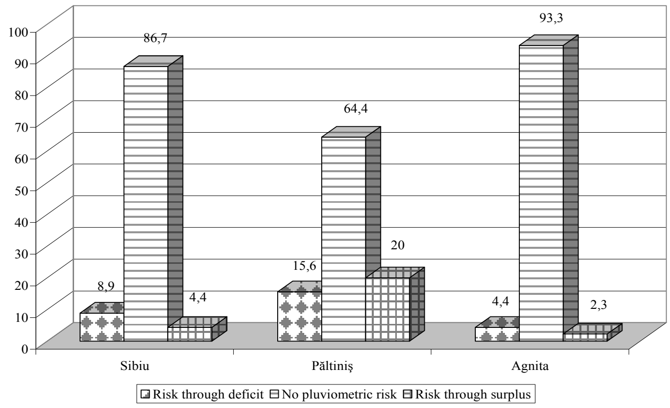

Fig. 1 Frequency according to groups with and without pluviometric risk in Sibiu, Păltiniş and Agnita in the interval 1961-2009

As for the risk through surplus or deficit in February, it can be noticed an almost equal distribution between the groups of risk and the ones pluviometrically normal (Fig. 2).
In Păltiniş, in February the group of risk through deficit is higher than the one through surplus, in Sibiu the one with risk through surplus is higher, and in Agnita the two groups of risk have equal proportions (Barbu, C. H., Spânu S., Petru G., 2007).
The group with no pluviometric risk represents 42,3% - 48,9% of the total months of June that have been analyzed in the depression and plateau area and over half in Păltiniş (55,6%).

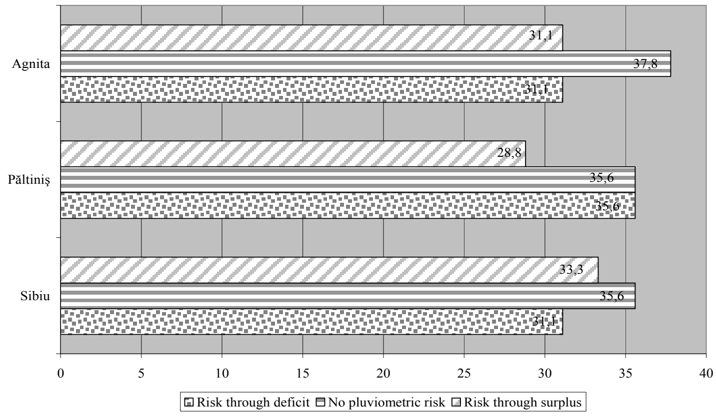

Fig. 2 Frequency according to groups with and without pluviometric risk in Sibiu, Păltiniş and Agnita in February (1961-2009)

In all the three units of relief, the risk through deficit reaches higher values than the one through surplus (Fig. 3). If in the case of February the average quantity of precipitations to which the monthly values were compared was low, this time the deficit is even more severe, since the reference is being made to the rainiest month of the year.

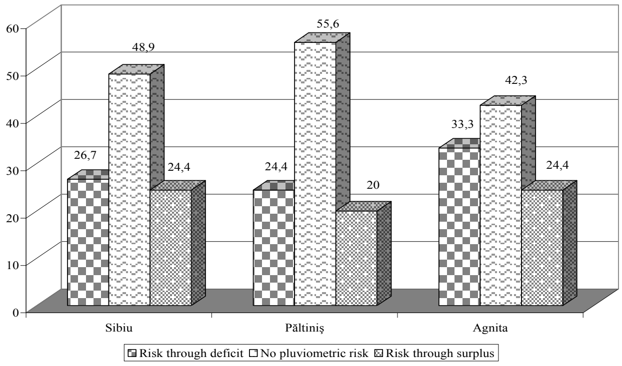

Fig. 3 Frequency according to groups with and without pluviometric risk in Sibiu, Păltiniş and Agnita in June (1961-2009)

The lower the temporal scale is, the greater the frequency of the high percentual deviations. Both in June and in February, the droughty domain has the highest values, followed by the rainy and the normal one.

The effects of the precipitations surplus, but even more those of the precipitations deficit, are especially felt by the agriculture, the working sector that is most sensitive to climatic conditions.

The direct effect of precipitations on crops is determined by the nature and quantity of precipitations. Mainly, precipitations have an effect on the seeds germination, process that is directly affected, in a negative manner, if the precipitations are in excess or are not abundant enough.

For the crops, the maximum yield is given by the precipitations that fall during the phenophases that are critical for their growth, phases in which the water intake is high. If the necessary water limits are exceeded, plants are exposed to a hydric stress which affects the quantity and quality of the harvest. There also are processes that cannot take place in the

absence of water in the soil, or in a situation with water surplus, as in the case of the germination.
During the plants' florescence period, precipitations can be harmful, because they interfere in the process of fecundation, by washing away the pollen. Downpours also exert a mechanical action on the plants, leading to the rootedness weakening or the uprootal of plants, especially if the precipitations are accompanied by wind intensifications. If the rain drops have a great diameter, they can shake down flowers, fruits, and seeds before their ripening and can cause the covering up with earth of small plants, thus stopping their growth. An abnormally great quantity of precipitations can lead to floods, which cause the suffocation of plants, the decrease in the quantity of dry matter in the plant, also reducing the capacity of the plants to resist to the attack of diseases and pests. If the precipitations are not in a sufficient quantity or are not at all present during the period in which the vegetation absolutely needs them, the plants stop growing, fade, get dry and die.
From an agricultural point of view, rain is useful or efficient only if it can be used by the plant, because in many cases important quantities of water are lost through the surface flow or percolation (Iagăru P., 2010).

CONCLUSIONS

By applying this method, it was possible to obtain a synthetic estimation of the real analysed parameters, in their evolution in time and space. Based on these estimates a prognosis regarding the evolution of phenomena with pluviometric risk was elaborated. Cibin hydrographic basin is among the areas with an average vulnerability to the quantity of precipitations.
This study demonstrates that the precipitations have both local and regional effects. A rain shower that fell in the mountain region spreads its effects in an area much larger than the one in which it manifested directly. The effects of this phenomenon can be felt immediately, but also for a long period of time afterwards, through the components of the geographical environment that have been directly or indirectly influenced. The effects of precipitations often determine irreversible effects.
The climatic changes will determine both the increase in the quantity of precipitations at the planet's level, and the rise of the ocean level, through the melting of the ice cap and of the glaciers and through the warming of the ocean's water.
The quantity of precipitations will grow, but rains will more often have a torrential character, being accompanied by phenomena related to storms and by wind intensifications. These precipitations will disrupt the hydrologic system through the decrease of the infiltration and the accentuation of the rapid surface flow, which will determine major increases in the debit and level of rivers generating deluges and floodings. (Sorocovschi, V., 2003)
The problems related to the water economy are of utmost importance and that is why both the resources and the hydric sources must be carefully administered.

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